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Original Research Article

Sexual dimorphism in various angles of north Indian hip bone- A rarely explored zone!

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ABSTRACT

Introduction: Identification of sex of the deceased is of prime importance for anatomists & forensic experts. Hip Bone is considered as the most ideal bone for studying sexual dimorphism due to the role of bony pelvis in child bearing. The present study aims to determine if there is any sex difference between the four angles of the hip bone, to bring the attention of anatomists to this less explored zone in morphometry of hip bones and provide a database for the North Indian population.

Materials and Methods: The present study was performed on 100 Hip bones belonging to North Indian Region. Four angles of the hip bone were measured - Iliopubic angle, Ischio-Pubic angle, Ilio-Ischiatic angle and Angle of Torsion. All the results were statistically analysed.

Results: On analysis of the results, while iliopubic & ilioischiatic angles were more in males, ischiopubic angle & angle of torsion measured more in females. However only ischiopubic angle was found to be significantly sexually dimorphic. No fixed pattern or significant difference was found with respect to side in any of these angles.

Conclusions: Not much significance can be assigned to the sexual dimorphism between the angles of Hip Bone. While plenty of comparative data is available for discriminating a hip bone to be a male or female for a large number of other parameters of hip bone, there is relatively meager data available to compare any sexual dimorphism in its angles.

1. Introduction

Identification of a person is of utmost importance in conditions of natural or man made disasters.[1] Damaged dead bodies or its remains, the skeletal parts and bones found in such situations, post a question of identification. At such times, gender identification is the first thing to be done. To add to this, sex identification from skeletal remains is also of utmost value for anthropological and medico legal purposes, primariliy in criminal investigations during the identification of missing persons. Another aspect is the role of sex identification for reconstruction of human skeletal remains from ancient fossils.[2] Thus, the determination of sex is statistically the most important criterion, as it immediately excludes nearly half of the population.

Nevertheless, there are natural anatomical variation to set norms within each sex which are affected by genetic, ethnic, environment al and cultural factors.[3] Skeletal components exhibit numerous metric and non-metric differences sex differences among st populations, which aid in sex determination.[4] Morphometric measurements have indicated asymmetry between right and left side of hip bone.[5–7] This further emphasizes the need to study sexual dimorphism of bones for Anatomists, Anthropologists and Forensic experts,[8] and also each population should have specific morphometric and morphological standards to optimize the accuracy of forensic identification.[9,10]

Hip Bone is bent in three dimensions. This bending of hip bone is an adaptation for upright posture. There is

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limited access to the angles of hip bone and also studies on the accuracy of different angles in various races are scarce. Thus arises a need for a study on the angles of hip bone.

2. Materials and Methods

The present study was performed on 100 adult human hipbones which were obtained from Department of Anatomy, Government Medical College, Amritsar. These were 80 male and 20 female bones, 50 each of right and left sides. The bones were intact, undamaged and without any morbid changes. Four angles of the hip bone, i.e. Iliopubic Angle, Ischiopubic Angle, Ilioischiatic Angle & Angle of Torsion of hip bone were measured using steel bars & protractor. Steps for measuring each angle are given below:

2.1. Ilio Pubic angle

It was measured by taking three points on hipbone. First point was taken at the tip of the anterior superior iliac spine (point B). Second point was taken at the centre of the acetabulum (point O). To locate the central point of acetabulum, an irregularity present in the acetabulum as well as inside the pelvis was taken.[11] Third point was taken at the tip of the posterior superior iliac spine (point C). The angle B-O-C (Figure 1) constitutes the ilio pubic angle.[12] For measuring it, one steel bar was kept touching point B & O" and another bar was kept touching point C & O" (O" is an imaginary point in the plane of acetabular rim directly opposite point O). Then the angle BO"C was measured using a protractor. (Figure 3)

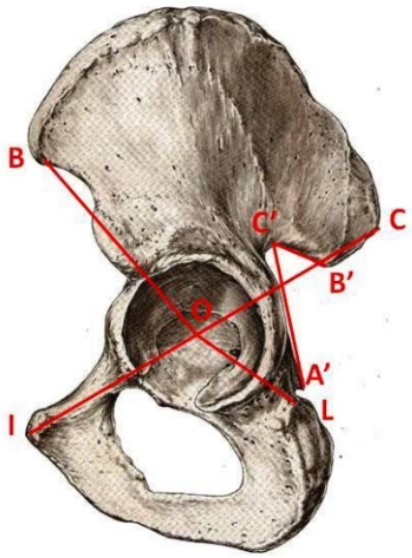

Fig. 1:

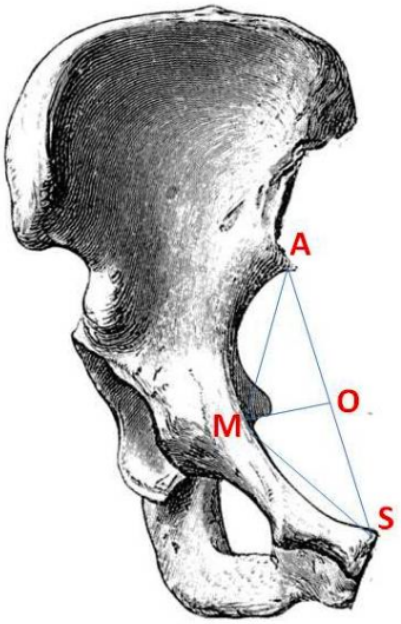

Fig. 2:

Fig. 3: Measuring iliopubic angle

2.2. Ischio pubic angle

It was measured by taking three points on the hipbone. First point was taken at the top of the symphyseal surface (point I), second point at the centre of the acetabulum (point O) and third point at the tip of the posterior extremity of the ischial tuberosity (point L). The angle I-O-L (Figure 1) constitutes the ischiopubic angle.[12] It was measured with the help of a protractor and two steel bars as in sr. no. 1. (Figure 4)

2.3. Ilio-ishiatic angle

For measuring it, three points were taken on the hipbone: first point at the tip of the ischial spine (point A '), second point at the tip of the posterior inferior iliac spine (point B') and third point at the margin of the greater sciatic notch which is most distant from the point A' and B' (point

Fig. 4: Measuring ischiopubic angle

C'). The angle A'-C'-B' (Figure 1) thus formed is the ilio-ischiatic angle.[12] It was measured with the help of the protractor. (Figure 5)

Fig. 5: Measuring ilioischiatic angle

2.4. Angle of the torsion

It is defined as the angle between the perpendiculars of the iliac plane and the ischiopubic plane. For measuring it, three points were marked on the hip bone. First point S was marked on the upper extremity of pubic symphysis, second point A is the auricular point ; which is the point of intersection of the arcuate line with the anterior border of the auricular surfaces and third point M is situated somewhere in the middle part of the arcuate line, more precisely at the intersection of this line with the y-axis.[12] For marking point M, a bar was kept touching the points S and A; length SA was noted and its midpoint O was determined with the help of measuring scale. From point O, a line was projected towards the arcuate line at right angle to the steel bar SA and point M was thus determined and marked on arcuate line where this perpendicular line intersects the later (Figure 6). Then angle SMA (Figure 1) constitutes angle of torsion. For measuring angle SMA two steel bars were kept representing lines SM and MA and the angle between these bars was recorded with the help of protractor (Figure 7).

Values thus obtained were tabulated and statistically analysed using SPSS Version 17. An attempt has been made to find out if there exists any significant difference with respect to sex or side in the various angles of Hip Bone.

Fig. 6: Locating point M (For angle of torsion)

Fig. 7: Measuring angle of torsion

3. Results

The results have been compiled in Tables 1 to 6. From Table 1 it can be seen that while ilio pubic & ilioischiatic angle measured more in males, ischiopubic angle & angle of torsion measured more in females. But the mean difference was significant only in case of ischiopubic angle (Table 2). When compared between the sides, the Iliopubic & ischiopubic angle were more on left side in both males & females, ilioischiatic was more on right side in both sexes whereas angle of torsion was more on left side in males & right side in females.

Table 1: Mean values, standard deviation and standard error of mean for various angles of hip bone both sexes

S. No.	Angle	Males (N=80)			Females (N=20)		
		Mean	S.D.	Range	Mean	S.D.	Range
1.	Ilio Pubic	101.03	2.50	92-107	100.4	1.39	98-103
2.	Ischio Pubic	111.68	4.18	90-116	113.6	1.87	110-116
3.	Ilio Ischiatic	71.78	10.28	50-90	67.55	9.51	55-85
4.	Angle of Torsion	122.98	5.38	112-135	123.70	5.34	114-134

Table 2: Independent samples test (Comparing mean differences between the two sexes)

S. No.	Angle	t-test for Equality of Means						
		T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
1.	Ilio Pubic	1.095	98	.276	.63750	.58231	-.51808	1.79308
2.	Ischio Pubic	-1.987	98	.050	-1.91250	.96230	-3.82214	-.00286
3.	Ilio Ischiatic	1.671	98	.098	4.23750	2.53525	-.79363	9.26863
4.	Angle of Torsion	-.530	98	.597	-.71250	1.34373	-3.37908	1.95408

Table 3: Values of various angles of hip bone with respect to sex & side

S. No.	Angle	Males(80)		Females(20)	
		Right (cm)	Left (cm)	Right (cm)	Left (cm)
1.	Ilio Pubic	100.75+ 2.53 (92-106)	101.32 + 2.46 (96-107)	99.9 + 1.28 (99-103)	100.9 + 1.37 (98-103)
2.	Ischio Pubic	111.52 + 4.01 (93-116)	111.85 + 4.40 (90-116)	113 + 2.0 (110-116)	114.2 + 1.61 (111-116)
3.	Ilio Ischiatic	72.47 + 10.18 (55-90)	71.10 + 10.46 (50-90)	69.10 + 9.44 (60-85)	66.0 + 9.82 (55-80)
4.	Angle of Torsion	122.95 + 5.01 (112-32)	123.02 + 5.78 (113-135)	123.80 + 5.80 (114 – 134)	123.60 + 5.14 (116-129)

Table 4: Independent samples test (Comparing mean differences between the two sides in males)

S. No.	Angles	t-test for Equality of Means						
		T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
1.	Ilio Pubic	1.028	78	.307	.57500	.55946	-.53880	1.68880
2.	Ischio Pubic	.345	77.347	.731	.32500	.94159	-1.54956	2.19956
3.	Ilio Ischiatic	-.595	78	.553	-1.37500	2.30962	-5.97310	3.22310
4.	Angle of Torsion	.062	78	.951	.07500	1.21129	-2.33650	2.48650

Table 5: Independent samples test (Comparing mean differences between the two sides in females)

S. No.	Angles	t-test for Equality of Means						
		T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
							Lower	Upper
1.	Ilio Pubic	.682	18	.110	1.0000	.59442	-.24883	2.24883
2.	Ischio Pubic	1.475	18	.158	1.20000	.81377	-.50967	2.90967
3.	Ilio Ischiatic	-.719	17.973	.481	-3.10000	4.30878	-12.15240	5.95240
4.	Angle of Torsion	-.081	18	.936	-.20000	2.45402	-5.35571	4.95571

Table 6: Comparison of angles of hip bone with published studies

Authors	**Present Study**		**Orban 198012**	
Population	**North Indians**		**French & Belgian**	
Angles	**Males**	**Females**	**Males**	**Females**
Ilio Pubic	101.03+ 2.50	100.4 +1.39	106.4° + 6.23	103.4° + 5.68
Ischio Pubic	111.68 +4.18	113.6 + 1.87	110.5° + 5.42	113.2° + 4.31
Ilio Ischiatic	71.78+10.28	67.55 +9.51		
Angle of Torsion	122.98+5.38	123.70+5.34	112.3° + 4.02	110.0° + 4.88

4. Discussion

It has been discussed in the works of several published studies that Hip Bone is an ideal bone to stud y sexual dimorphism as it is most influenced by the reproductive hormones. While a lot of work has been done on its well known parameters like Greater Sciatic Notch, Ischiopubic Index, Acetabulum, Chilotic line, general measurements pertaining to ilium, ischium, pubis etc; there is a paucity of data if we try to compare the angles of the Hip bone. A single study by Orban[12] is available, who measured these angles in French & Belgian populations.

A look at Tables 1 and 2 shows that the Ilio-Pubic Angle in the present study is more in males as compared with females, although insignificantly. Also it was wider on left side in both the sexes, but difference was statistically in significant both in males & females. When compared with the study by Orban[12] [Table 6], it can be seen that, in both the studies it was *wider in males* but the differences were statistically significant in Orban's[12] study and insignificant in the present study. Also the table shows that this angle is slightly wider in Belgian & French than in North Indian population.

Further from Tables 1 and 2, it is seen that Ischio - Pubic Angleis significantly more in North Indian females than in males. Also Table 3 shows that is more on left side both in males & females, although the difference is insignificant in both (Tables 4 and 5). A comparison with Orban's[12] study (Table 6) shows that values of both the populations are comparable, and the angle is significantly *wider in females* in both studies.

It can also be seen from Tables 1 and 2 that the mean Ilio-Ischiatic angle in the North Indian sample, was *wider in males* as compared to females on both the sides but the difference was statistically insignificant. When compared on the two sides Table 3, it was wider towards right side in both the sexes, but the difference was statistically insignificant 4 & 5.

Lastly Tables 1 and 2 also denote that Angle of Torsion is slightly more in females as compared to males in the present study. Table 3 shows it to be more on right side in both males & females but the difference was insignificant in both (Tables 4 and 5). Earlier only Orban[12] had measured this angle. A comparison to Orban's[12] Study (Table 6) shows that, the angle of torsion is more in North Indians (Present Study) than in the French & Belgian population which may be due to racial influence. However when compared between the two sexes, while Orban[12] found it to be significantly more in French & Belgian males, it was more in females of the present study though the difference was statistically insignificant.

Chopra[13] performed a study on Angle of Pelvic Torsion in primates. He stated that the bony pelvis bears a close relationship to the body posture. He further mentioned in his study that the torsion of Hip bone is one its most prominent features, which is present between iliac & ischiopubic planes. However, Washburn[14] had mentioned that the bending back of ilium primarily took place to bring gluteus maximus behind the hip joint to make it an extensor. This has further made gluteus medius an abductor. Chopra[13] thus firmly advocates this change to be an important milestone for Human evolution. Thus this further highlights the significance of this angle, though it is not of much importance for sexual dimorphism.

5. Conclusion

The present study which is basically an observational study, has tried to attract the attention of workers towards the relatively lesser explored parameters of the hip bone, i.e. its angles and further advocates a need of more population specific studies on larger databases to prove or disapprove the authenticity & use of these angles for sexual dimorphism.

6. Source of funding

None

7. Conflict of interest

None.

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